

MTH-401

DISCRETE MATHEMATICS

LECTURE ZERO

Basic Information of the Course



Course Details:

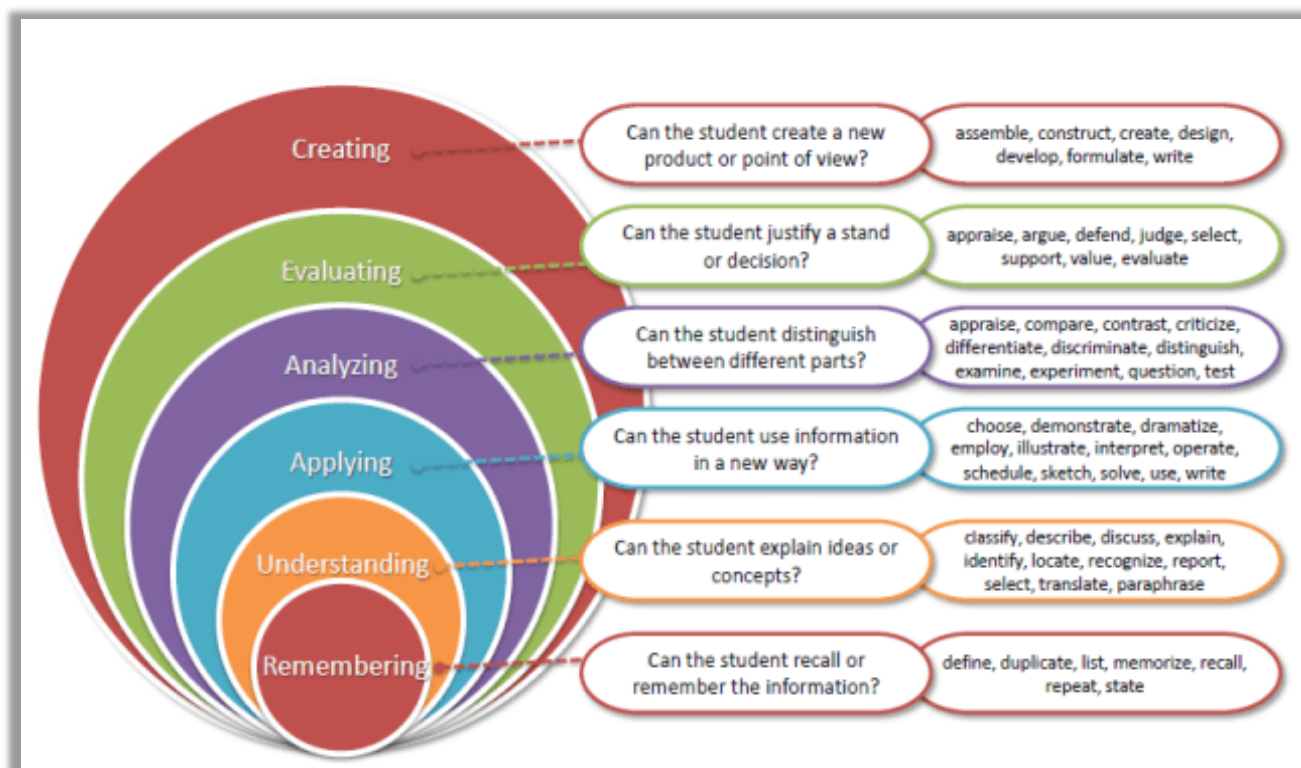
Lecture:-
3

Tutorial:-
1

Practical:-
0

Credits:-
4

Revised Bloom's Taxonomy



Course Outcomes

CO1:: understand methods for constructing and validating logical proofs.

CO2 :: explain recursive techniques for solving problems in combinatorics.

CO3 :: apply the equivalence and partial order relation properties on graph.

CO4 :: understand various graph-theoretic concepts and explore their applications.

CO5 :: apply concepts of planar graphs, Euler's formula, graph coloring, and tree properties in problem-solving.

CO6 :: compute the solution of linear congruences using the Euclidean algorithm.

Program Outcomes

PO1: Engineering knowledge:: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis:: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO12: Life-long learning:: Recognize the need for, and have the preparation and ability to engage in independent and life -long learning in the broadest context of technological change.

PSO3: Provide effective and efficient real time solutions using attained knowledge in inter -disciplinary domains for societal benefits through projects: Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Skill set attainment

- After studying discrete mathematics, you'll gain skills in logical reasoning, problem-solving, and mathematical proof techniques. You'll understand concepts like sets, relations, graphs, and algorithms. This knowledge is crucial for computer science, cryptography, and advanced mathematics.

Content Overview

- **Unit I**
- Propositional logic, propositional equivalences, quantifiers, Introduction to proof, direct proof, proof by contraposition, vacuous and trivial proof, proof strategy, proof by contradiction, proof of equivalence and counterexamples, mistakes in proof
- **Unit II**
- recurrence relation, modeling with recurrence relations, homogeneous linear recurrence relations with constant coefficients, Method of inverse operator to solve the nonhomogeneous recurrence relation with constant coefficient, generating functions, solution of recurrence relation using generating functions

Content Overview

- **Unit III**
- principle of Inclusion-Exclusion, Pigeonhole, generalized pigeonhole principle, relations and their properties, combining relation, composition, representing relation using matrices and graph, equivalence relations, partial and total ordering relations, lattice, sub lattice, Hasse diagram and its components
- **Unit IV**
- graph terminologies, special types of graphs(complete, cycle, regular, wheel, cube, bipartite and complete bipartite), representing graphs, adjacency and incidence matrix, graph isomorphism, path and connectivity for undirected and digraphs, Dijkstra's algorithm for shortest path problem

Content Overview

- **Unit V**
- planner graphs, Euler formula, colouring of a graph and chromatic number, tree graph and its properties, rooted tree, spanning and minimum spanning tree, decision tree, infix, prefix, and postfix notation
- **Unit VI**
- divisibility and modular arithmetic, primes, greatest common divisors and least common multiples, Euclidean algorithm, Bezout's lemma, linear congruence, inverse of $(a \text{ modulo } m)$, Chinese remainder theorem, encryption and decryption by Ceasar cipher and affine transformation, Fermat's little theorem



Assessment Model

CA category & evaluation: **A0202**

Exam category: **13**

Mid Term Exam: **All MCQ**

End Term Exam: **MCQ + Subjective**

Marks Distribution:

ATT: 5 CA: 25 MTT: 20 ETT: 50

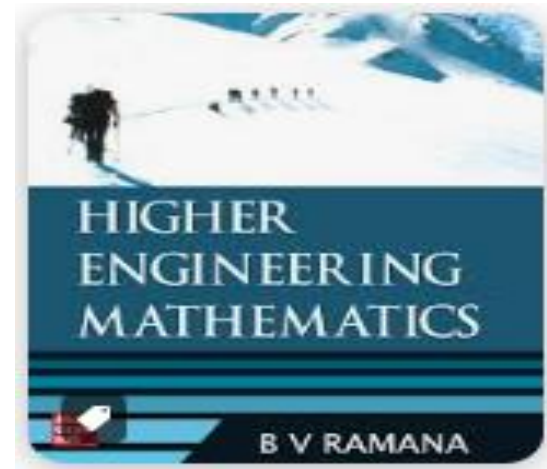
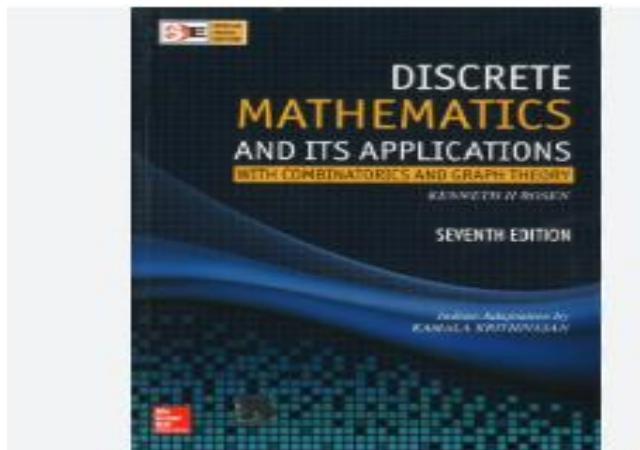
Textbook and reference book

Textbooks:

1. DISCRETE MATHEMATICS AND ITS APPLICATIONS by KENNETH H ROSEN, MCGRAW HILL EDUCATION

References:

1. HIGHER ENGINEERING MATHEMATICS by B. V. RAMANA, MC GRAW HILL



Blended or Flipped Learning

- This course includes Flipped class teaching approach as per the links available in IP for certain lectures.

Blended or Flipped Learning

- Blended or Flipped Learning is an educational approach that combines traditional classroom instruction with hands-on, experiential learning opportunities.
- It combines different modes of learning, such as in-class lectures, online materials, and hands-on experiences.
- Flipped classroom teaching includes students to watch online lectures, collaborate in online discussions, or carry out research at home, while actively engaging concepts in the classroom, with a teacher's guidance.

Introduction to Discrete Mathematics

- What is Discrete Mathematics?
- Why do we need it?

Discrete Mathematics

What is Discrete Mathematics?

- ☐ Study of mathematical structures that are discrete rather than continuous.
- ☐ Involves integers, graphs, logical statements, etc.
- ☐ Does not require the notion of continuity.

What do we need it?

- Provides mathematical foundations for computer science and cryptography.
- Essential for algorithms, data structures, and network theory.
- Helps in handling discrete data efficiently in software development and information theory.

Some Practical Applications of Discrete Mathematics

Why to study logics and Proof ?

What skills

You can solve problems

do you need

You like numbers

to study

You are a good logical thinker.

Computer Science/ IT?



Computer programs are written in special, symbolic languages, e.g., Fortran, C++, Lisp, Prolog. These languages contain features of logical symbolism, and Lisp and Prolog are derived from formal languages for logic. Through such connections, the study of logic can help one in the design of programs.

APPLICATIONS OF RECURRENCE RELATION AND GRAPH THEORY...?

HANOI TOWER

Math

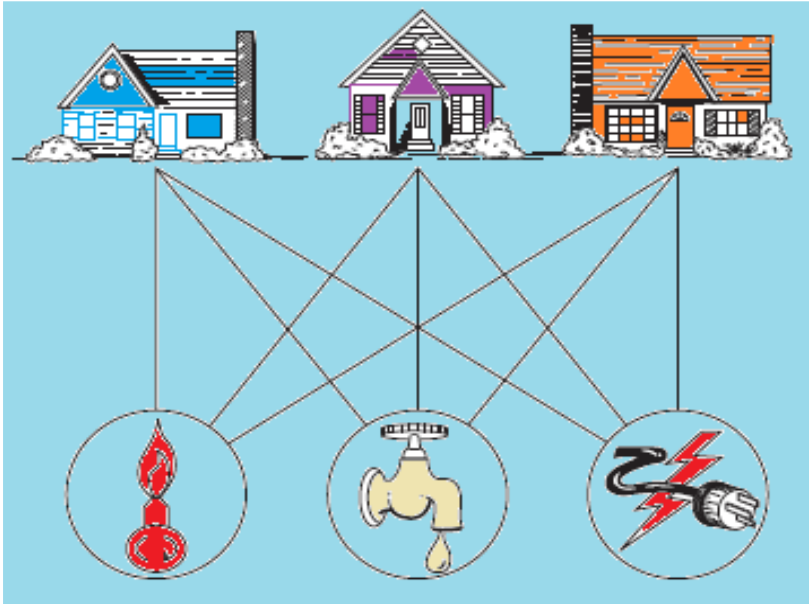
Solution of tower of Hanoi game for n disk?



Discs	Moves
1	1
2	3
3	7
4	15
5	?
n	?

Solution of Tower of Hanoi game can be obtained by first order linear recurrence relation $y_{k+1}-2y_k = 1$ under $Y(0)=0$]. For more details please visit

<https://www.mathsisfun.com/games/towerofhanoi.html>



Application of graph theory

Consider the problem of joining three houses to each of three separate utilities, as shown in Figure . Is it possible to join these houses and utilities so that none of the connections cross?

In this section we will study the question of whether a graph can be drawn in the plane without edges crossing. In particular, we will answer the houses-and-utilities problem.



Assignment problem

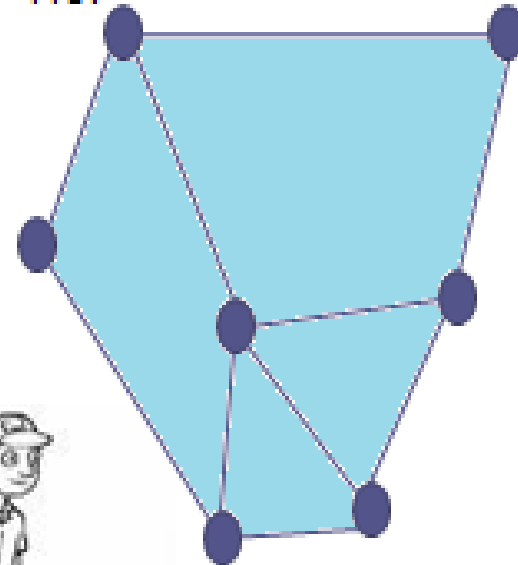
There are 50 students in the class and teacher needs to prepare minimum number of class test for them in a way such that no two consecutive students get the same assignment.

It can be done via graph coloring , teacher can find chromatic no. of graphical representation of students

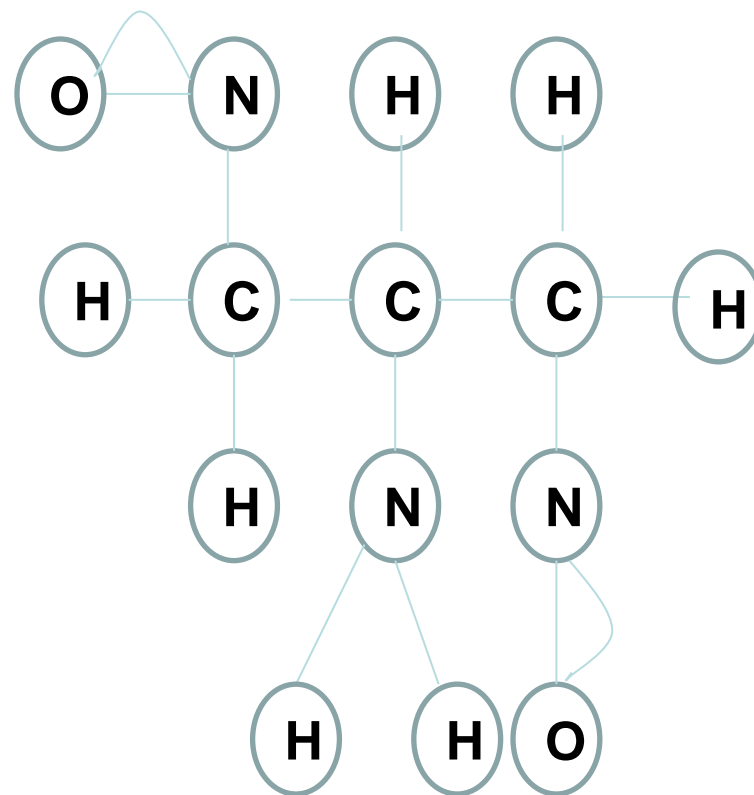
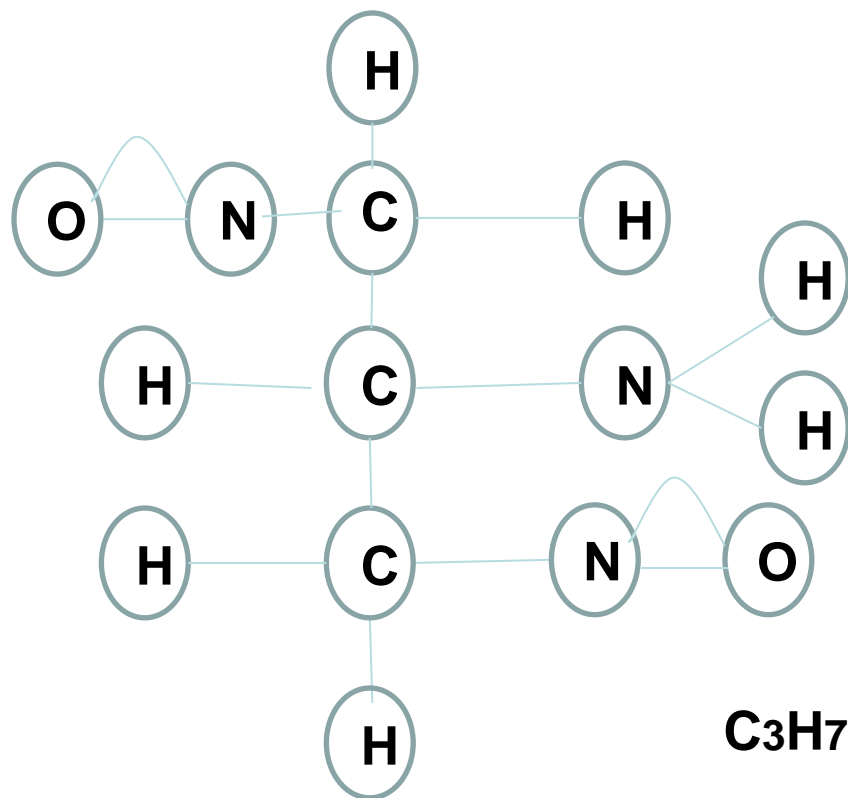
Postman Problem

- A postman begins in the post office, has to traverse all the streets, and returns to the post office in a shortest possible distance.

P.O.

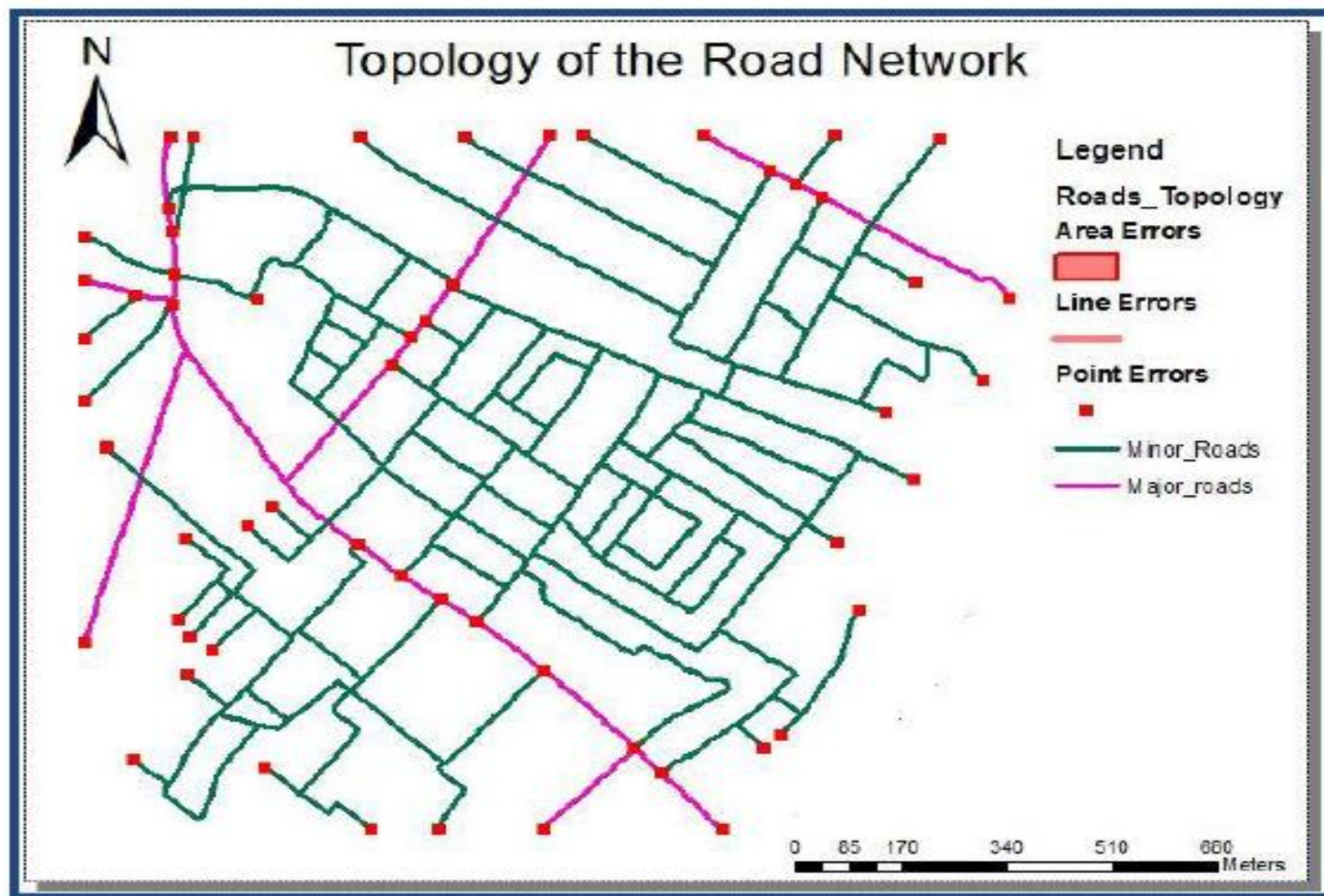


Determining if two compounds with the same formula are identical.



Graph isomorphism problem

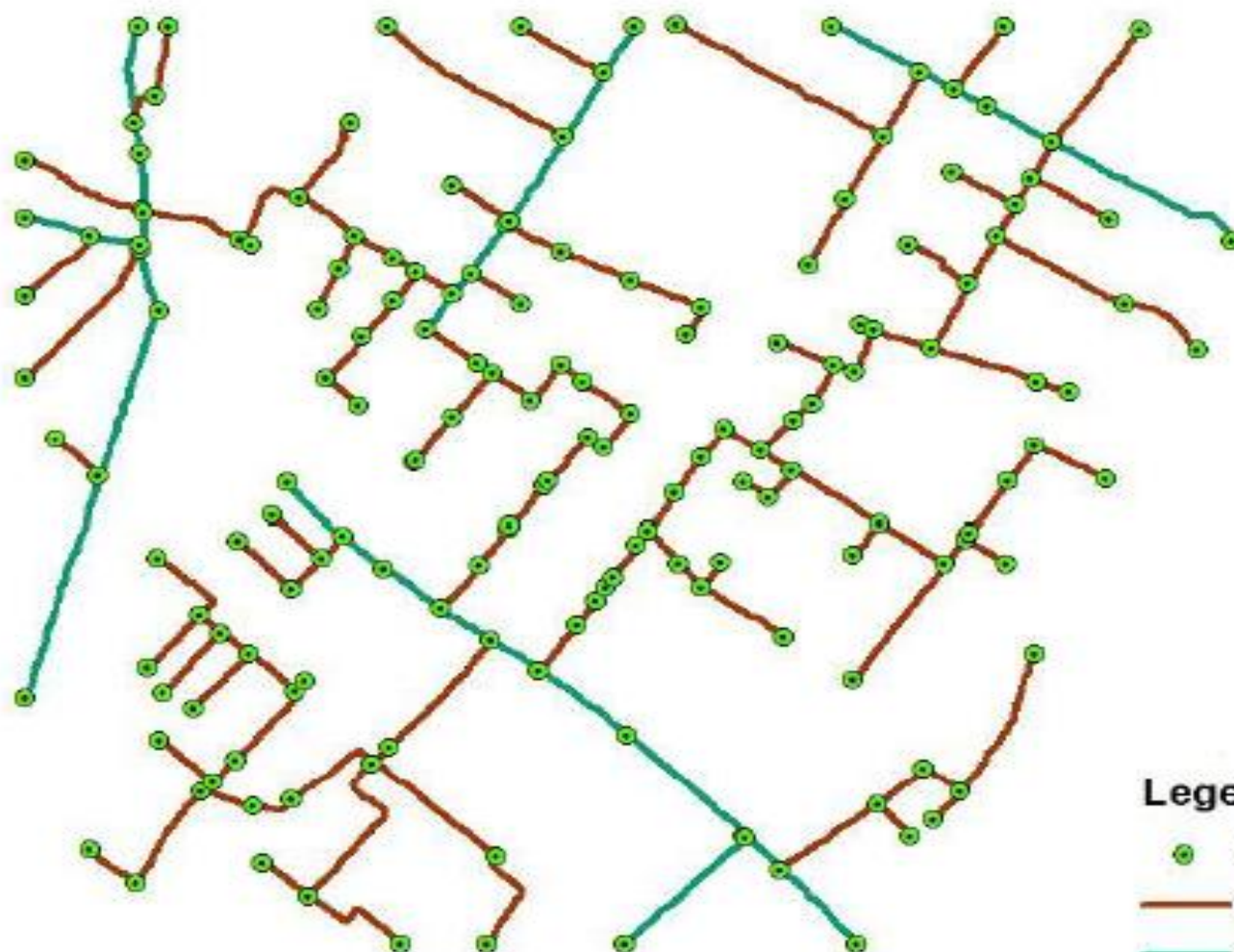
Minimum Spanning tree






Topology for the Road Network

Minimum Spanning Tree of Road Network

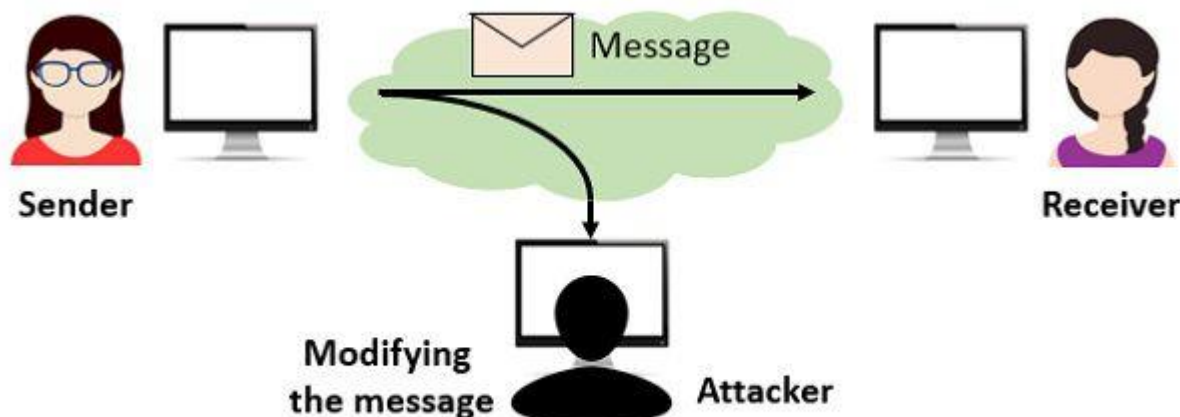
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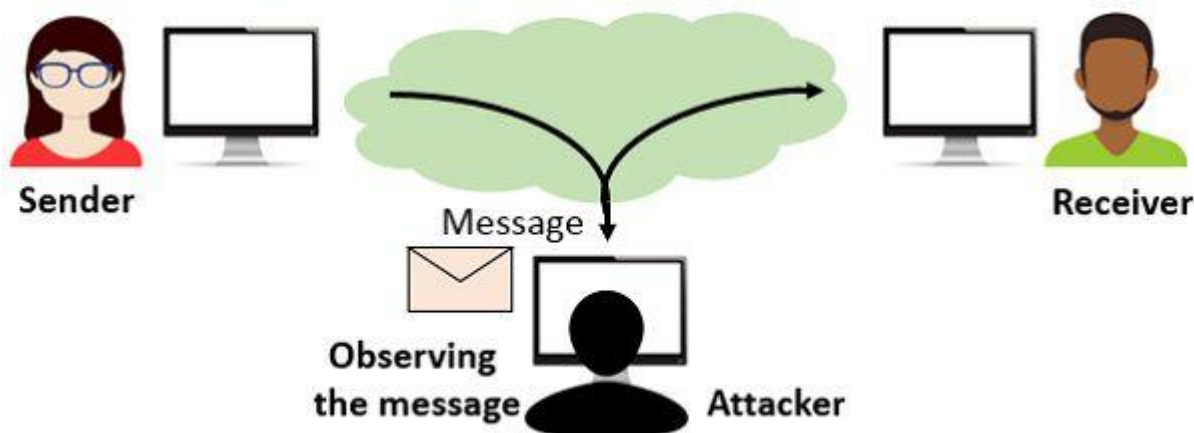
Legend

-  Roads_ND_Junctions
-  Minor_lyr_1
-  Major_lyr_1

Cryptography



Passive Attack



Active Attack



EDU-REVOLUTION: BE THE CHANGE INITIATIVES

MOOC

- What is MOOC?
- Massive Open Online Courses (MOOCs) are free online courses available for anyone to enroll. MOOCs provide an affordable and flexible way to learn new skills, ...



Moocs

SWAYAM-NPTEL

Discrete Mathematics

By Prof. Sudarshan Iyengar | IIT Ropar

https://onlinecourses.nptel.ac.in/noc25_cs26/preview

To register for

NPTEL/MOOCs/Certifications.

The link for registration

UMS Navigation-----> LMS-----> Edu-Revolution: Be the Change



Discrete Mathematics

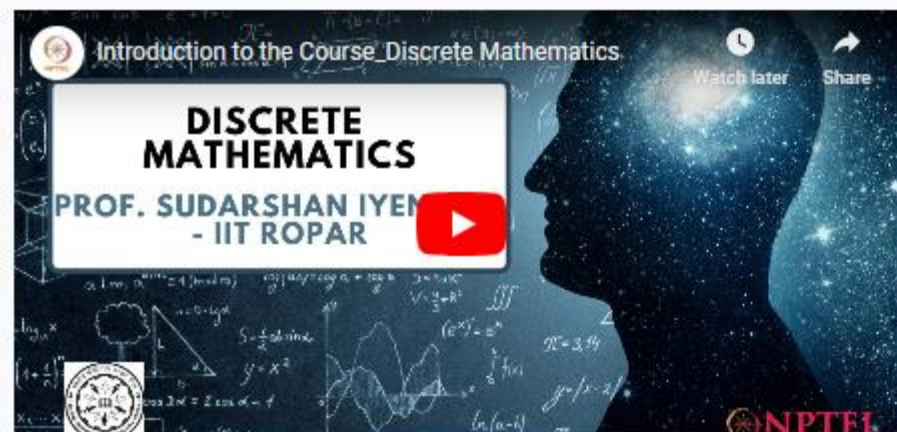
Start Date :	20 Jan 2025
End Date :	11 Apr 2025
Enrollment Ends :	27 Jan 2025
Exam Registration Ends :	14 Feb 2025
Exam Date :	26 Apr 2025 IST

Discrete Mathematics

By Prof. Sudarshan Iyengar | IIT Ropar

Join

Learners enrolled: 1832 | Exam registration: 22



ABOUT THE COURSE :

The course will be an introduction to Discrete Mathematics which comprises of the essentials for a computer science student to go ahead and study any other topics in the subject. The emphasis will be on problem solving as well as proofs. We will be providing motivational illustrations and applications throughout the course. The course doesn't assume any pre-requisites except for high school level arithmetic and algebra.

INTENDED AUDIENCE: Any Interested Learners

INDUSTRY SUPPORT: Every industry expects candidates to have good aptitude. This course sharpens the overall Quant skills.

Summary

Course Status :	Upcoming
Course Type :	Core
Language for course content :	English
Duration :	12 weeks
Category :	<ul style="list-style-type: none"> Computer Science and Engineering Foundations of Computing Foundations of Mathematics
Credit Points :	3
Level :	Undergraduate
Start Date :	20 Jan 2025
End Date :	11 Apr 2025
Enrollment Ends :	27 Jan 2025
Exam Registration Ends :	14 Feb 2025
Exam Date :	26 Apr 2025 IST

Note: This exam date is subject to change based on seat

Project based CA for CARE (refer EDU Revolution initiative)/Regular projects:

CA Modification

- There are two continuous assessments:
- Both the CA's are situation based test

Student can opt for alternate CA and give his/her expression of students on the UMS link

UMS Navigation-----> LMS-----> Edu-Revolution: Be the Change

Grade Revision and Overall Welfare (GROW):

- The students about opportunity to improve their existing grades through their involvement in the following:
 - i. Competitions/Hackathons
 - ii. Freelancing establishments of Entrepreneurial Ventures for students to attain benefits
 - iii. How to Publications/Patents/Copyrights
 - iv. Performance in Recruitment/Competitive/Eligibility exams



Open Education Resources

- <https://www.mathsisfun.com/games/towerofhanoi.html>
- <https://www.javatpoint.com/discrete-mathematics-binary-trees>
- <https://www.mymathtables.com/calculator/digital/caesar-cipher-encrypt-decrypt-converter.html>
- <https://nptel.ac.in/courses/106106094/>
- https://www.philippe-fournier-viger.com/tools/draw_hasse.php



Lets Start Working!

Let's start the journey of learning Discrete Mathematics.

